

ASSESSMENT OF CURRENT CONDITIONS

The CIR DOQs were used as base maps for constructing a Geographic Information System (GIS) database using ArcViewTM version 3.3 software. This approach was used so that the data could be easily updated and compared to other spatial data sets. Additionally, existing reports containing information on wetlands were reviewed, several conservation easements were visited, many inventoried areas were ground-truthed, and low altitude aerial flights were conducted to inspect and photograph wetland and riparian areas.

Review of Subdivision Documents and Conservation Easements for Wetlands

The first step in the inventory of wetlands was to locate sites of known wetlands to see how the different types of wetlands appeared on the CIR imagery. Available reports containing information on the locations of wetlands, including in some cases delineated wetlands, were reviewed. The City of Bozeman Critical Lands Study, which included a map of wetland features around the Bozeman urban area, was included in the review. This report covered an area of about 8.5 miles along the north and west sides of the Bozeman urban area (Wetlands West, 1998).

Documents submitted to the Gallatin County Planning Department for subdivision approval were also reviewed. Many of these reports contained maps and other information on wetlands, including delineated wetlands. Table 6 lists the subdivision projects that were reviewed for wetland information.

Table 6
Subdivision Application Documents Reviewed for Wetlands

Project Name	Wetland Information In Report
Antelope Ridge	No
Baxter Meadows	No
Bridger Peaks Town Center	Yes
Cattail Creek	No
Day Ranch	Yes
Elk Grove	Yes
Falcon Hollow	Yes
Gallactic Park	Yes
Gallatin Park	Yes
Gallatin Center	No
Green Hills Ranch	Yes
Harry Piper Property	Yes
Harvest Creek	Yes
Lake Amended	No
Manley Meadows	Yes
Meadow Brook Estates	Yes
River Rock	No
River Rock Phase II	No
Saddle Peak	No
Stone Ridge	Yes
Sundance	No
Triple Tree	No
Valley Ice Garden	No
Valley West	No

Several properties in the project area with known wetlands and riparian areas were also visited with landowner permission. These properties either had conservation easements or were being considered for conservation easements. The sites visited included the FDD ranch near Manhattan, the Tim Crawford property northwest of Belgrade, and the Milesnick Ranch north of Belgrade.

Description of Wetland and Riparian GIS Layers

In order to inventory wetlands and riparian areas it was necessary to select the types of map units or “polygons” used to construct the GIS database. One problem encountered was that in many areas wetlands and riparian areas are mixed. For example riparian wetlands along the West Gallatin River were mixed with non-wetland riparian vegetation. To resolve this problem it was decided to create a GIS layer referred to as “*Wetlands*” if the area was clearly a wetland area and there was no significant canopy cover hiding the wetland plants from view on the CIR imagery. If the area contained trees and shrubs and the ground surface could not be viewed on the CIR imagery it was included within a GIS layer referred to as “*Riparian/Wetland Mixed*”, to indicate the possible presence of wetlands under the riparian tree and shrub canopy cover.

Mapping Conventions

Minimum Mapping Unit - The minimum mapping unit size selected for the inventory was ½-acre for both the wetlands and riparian/wetland mixed layers. The minimum mapping unit is a measure of the smallest site consistently mapped throughout the project area. Several sites were identified that are smaller than the minimum mapping unit if they could be clearly identified on the CIR imagery, but it is likely that many smaller features were missed.

Split and Continuous Polygons - Many of the areas mapped were bisected by roads, residential developments, or features such as constructed ponds. In many instances these bisecting features still maintained wetland or riparian characteristics and were mapped as a continuous polygon (area). However, features such as major roads often created a large disturbance within the feature. As a convention, if the bisecting feature was wider than 8 meters for a wetland polygon, the mapped area was split to exclude the bisecting feature. If the bisecting feature was wider than 15 meters for a riparian/wetland feature it was split to exclude the bisecting feature. Examples of split and continuous polygons with bisecting roads are shown in Figure 8. The wider distance for the riparian class was introduced as a matter of parsimony, since the linear nature of these ecosystems often resulted in the occurrence of numerous bisecting features.

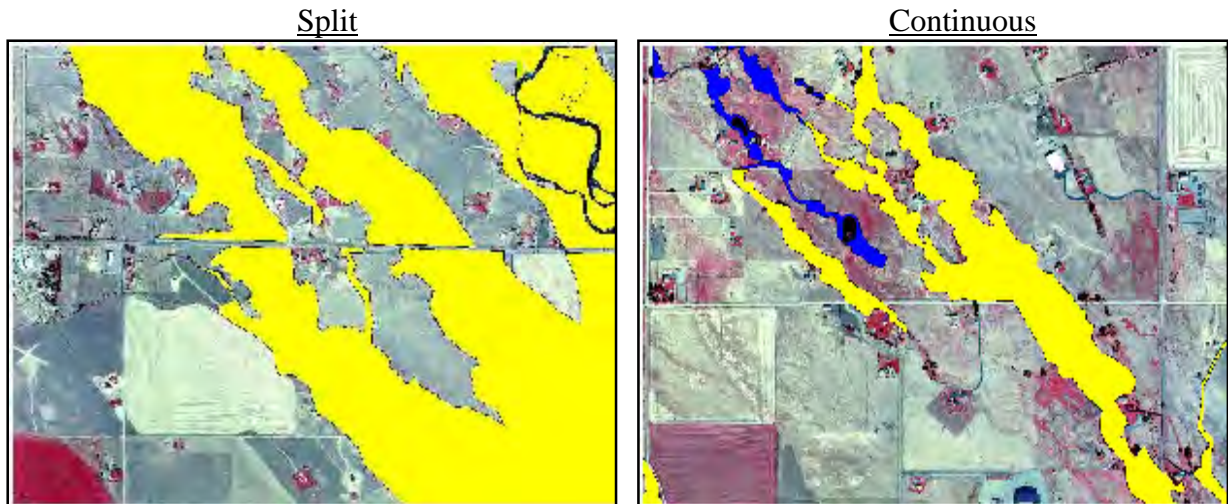


Figure 8. Examples of split and continuous riparian mapping polygons (yellow).

River Channel Mapping - The two primary river channels in this project are the East Gallatin and West Gallatin Rivers. The West Gallatin River floods with greater intensity than the East Gallatin. As a result, the river creates visible flood scarring that occurs both on the banks and on inter-channel islands. The flood-scarred areas are generally sand or gravel areas, with little or no vegetation, and appear light gray to grayish-green colored on the CIR imagery as shown in Figure 9. The lateral migration of the active channels is evident in the widespread flood scars that occur along the river corridor. To allow for future analysis of channel migration, the active river channels were mapped and added to the GIS database as a surface water layer.

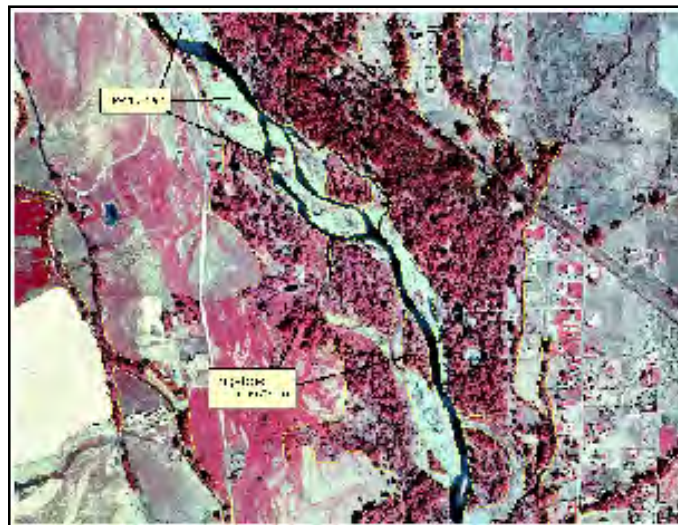


Figure 9. Example of flood scarred, vegetated, and active river channels along the West Gallatin River.

Analysis of Wetlands and Riparian Areas on CIR Imagery

After known areas of wetlands obtained from available reports and field inspection of conservation easements were mapped, the remaining wetland areas had to be inventoried by analyzing the CIR imagery. Early in the process, simultaneous analysis of the CIR imagery

and additional field inspections were completed to aid in identification of wetland features on the CIR imagery. Identifying riparian areas was easier because the focus was on identification of woody riparian vegetation, which was readily visible on the imagery.

Differences in color, tone, and texture on the CIR imagery were used to aid in the inventory of wetland and riparian areas. In most cases, a bright red color on the photo generally indicates lush vegetation and low to moderate surface moisture, while a darker red color is displayed in vegetated areas with saturated or near saturated soils. Brighter colors such as yellow or white indicate that the vegetation and soil contain very little moisture and thus are generally not indicative of wetlands. Smooth textures, and uniform color usually indicate that the vegetation is of approximately the same height and forms a continuous canopy. One example of this would be a wet meadow where the grasses grow in close proximity to each other and the blades are of a similar blade height and shape. Areas of woody riparian vegetation, such as cottonwoods and willows, have several canopy levels and display a rough texture on the CIR imagery. Irrigated crops generally show up as uniform bright red areas with geometric shapes (circles and squares).

The dominant tree and shrub species were identified for each area inventoried. In areas with co-dominant tree and shrub species 2-3 species for each vegetation class were identified. Grassy vegetation was not documented due to the high diversity of grasses and the inability to distinguish different types of grasses on the CIR imagery.

Analysis of the colors and textures on the CIR imagery, along with ground-truthing of inventoried sites, allowed for identification of the larger trees and shrubs present in the area. This was harder for smaller shrub species, which were often estimated based on data from ground-truth sites. In addition to using color, tone, and texture on the CIR imagery to inventory wetlands, other sources of information were also used. A GIS layer was obtained from the Gallatin Conservation District for hydric soils. This layer showed hydric soils, as mapped by the Natural Resource Conservation Service (NRCS), divided into classes based on the percent of hydric soils within the soil mapping units. The layer could be viewed over the CIR imagery to see if hydric soils were present in a suspected wetland area. The GIS layer of the NWI data was also overlain to check areas for wetlands inventoried by NWI.

Ground-Truthing and Low Altitude Aerial Survey

Once the initial GIS layers were constructed for the inventoried areas using the CIR imagery, ground-truthing was completed to check the accuracy of the on-screen digitizing. The project area was divided into four quadrants and larger scale field maps were printed with the CIR imagery as a base and the inventoried areas shown on the maps. A one-day field training exercise was held to show project participants and volunteers how to check the sites inventoried. The field maps were then used along with a Wetlands Ground-Truth Survey Sheet to conduct the ground-truthing. A sample of a completed survey sheet is included in Attachment B. The survey sheet included questions on the vegetation, presence of surface water, saturated soils, landuse, and evidence of alteration.

Over 240 field sites were ground-truthed, including the sites visited while inspecting conservation easements. The locations of the sites visited were documented by either using a GPS unit, or by marking the position on the CIR field maps provided to the folks doing the ground-truthing. The sites marked on the field maps were entered into the GIS project using

on-screen digitizing. A data layer was created for the GIS project to show all of the ground-truthing sites. This layer is shown in Figure 10 as it appears in the project. Selected areas were also flown at low altitude in July of 2003 to inspect areas that were being mapped on the computer using the CIR imagery. Low altitude, oblique, natural color digital photographs were taken of selected sites for comparison with the CIR imagery and photographs taken while ground-truthing. Using the combination of computer mapping with the CIR imagery, ground-truthing, and low altitude aerial survey significantly improved the understanding of how and where land-use changes have impacted wetlands and riparian areas. Figure 11 shows how a riparian/wetland mixed site appears on the CIR imagery, from low altitude in natural color, and on the ground. Figure 12 shows how a wetland area appears on the CIR imagery and from low altitude in natural color.

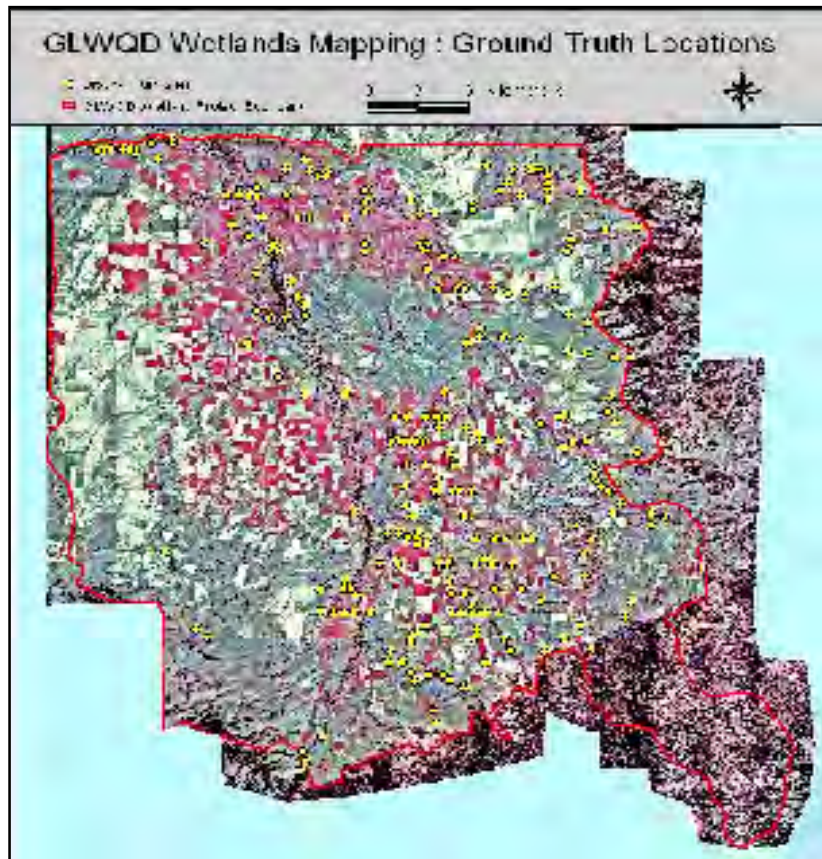


Figure 10. Locations of ground-truthed sites within the project area

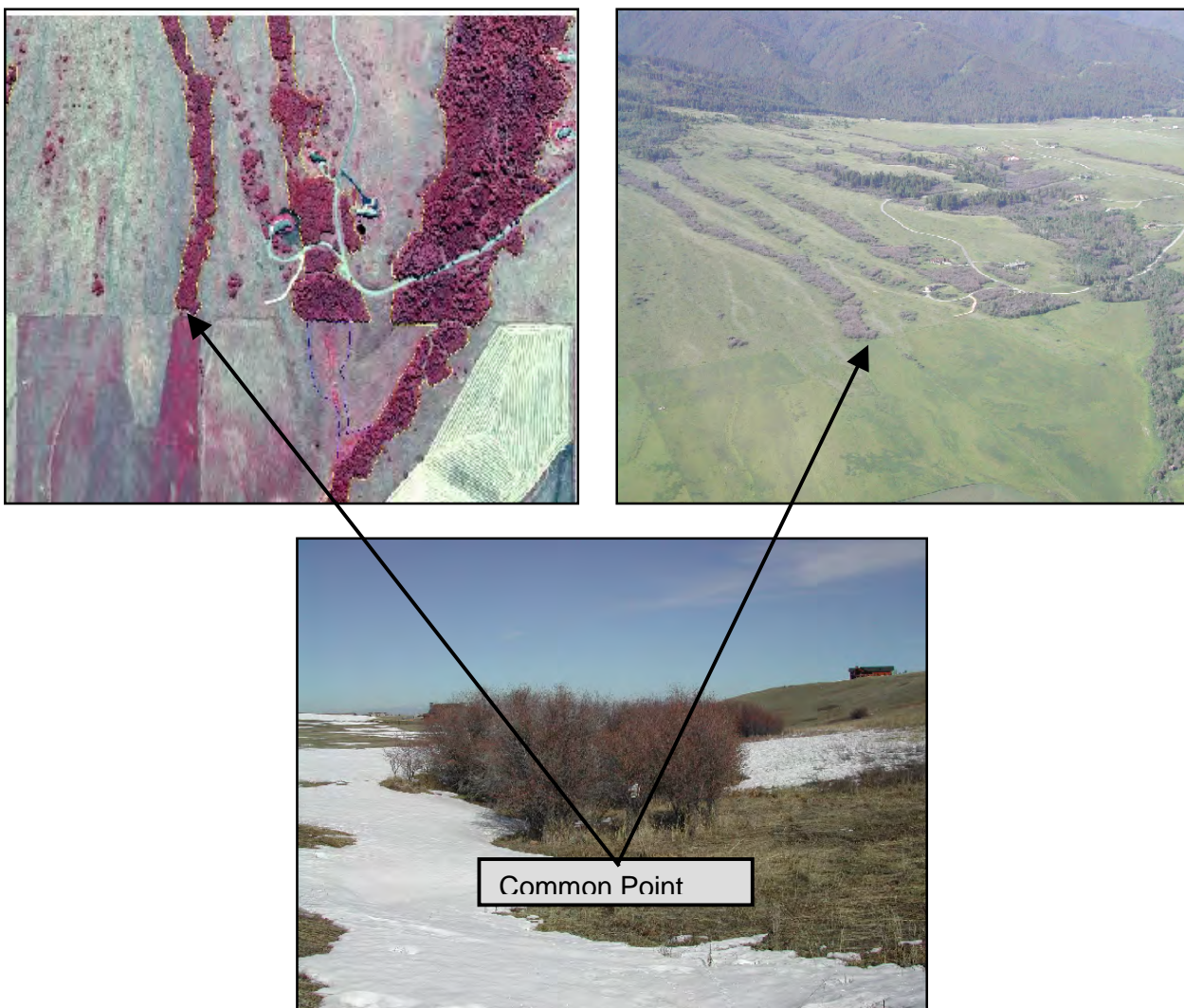


Figure 11. Example of a riparian/wetland mixed site as seen on CIR imagery, from low altitude in natural color, and from the ground.

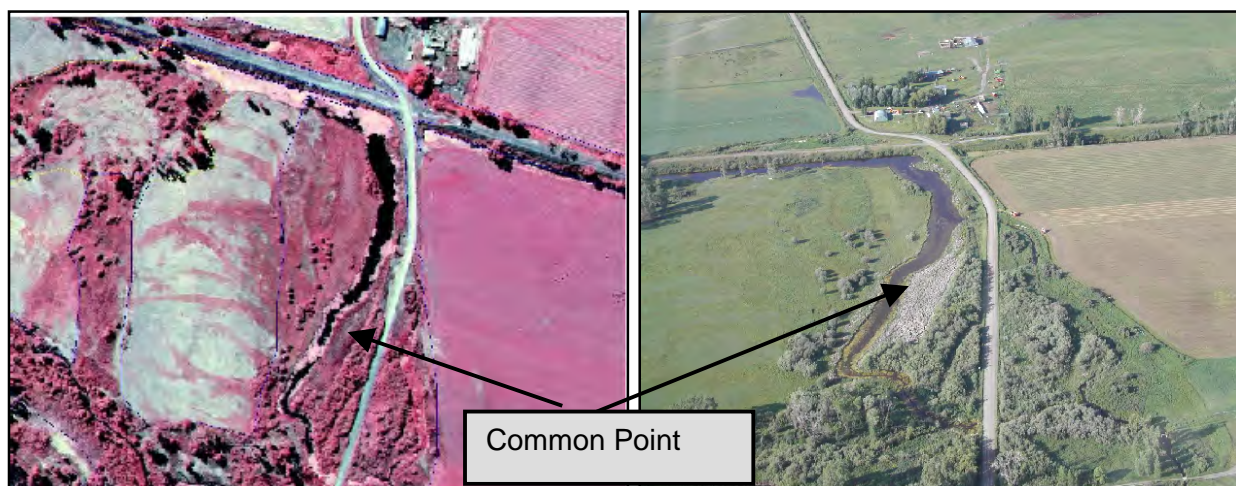


Figure 12. Example of a wetland site as seen on the CIR imagery and from low altitude.

Inventory of Wetlands and Riparian Areas

The areas inventoried as *wetlands* and *riparian/wetlands mixed* are considered representative of conditions as of 2001. Ground-truthing and the low altitude aerial flights were conducted through the summer of 2003. A map showing the inventoried *wetlands* and *riparian/wetlands mixed*, on the CIR base map, is provided in Attachment C. The map shows the “big picture” in terms of the spatial distribution of wetlands and riparian areas in the Gallatin Valley and upper Bozeman Creek watershed. Several regional patterns can be seen. The largest concentration of wetland features is in the north-northwestern portion of the valley. This area shows up on the CIR imagery as an area of continuous shades of red. Much of the land in this area is sub irrigated, with numerous springs and spring creeks. Ground water flow mapping by Hackett (1960), and Slagle (1995) shows that this area represents the regional ground-water discharge area for the Gallatin Valley aquifer system (see Figure 4, page 6).

The second largest concentration of wetland and riparian features is associated with the West and East Gallatin Rivers. Both these rivers support a continuous series of wetland and riparian areas. In the southeastern portion of the valley, numerous smaller, more linear wetland features are present, which follow the general pattern of the perennial drainages coming off of the Gallatin Range. These wetland features are more discontinuous. This area also includes several smaller wetland features formed on slopes that are supported by spring discharge or leaking irrigation ditches.

The northern and northeastern portion of the project area, including the Horseshoe Hills, lower Dry Creek Valley, and the southwestern facing flanks of the Bridger Range are relatively dry. Wetland and riparian features are limited in these areas to the perennial drainages. The western portion of the project area, which includes the Madison Plateau is also dry, but contains several isolated wetland and riparian areas associated with irrigation.

In the upper Bozeman Creek watershed numerous small wetland features were documented but many areas were smaller than the minimum mapping unit size of ½ acre. One exception is the Mystic Lake area, which contains several large wetland areas, and is visible on Attachment C. Mystic Lake was dammed in the past, but the dam has since been breached. A smaller lake now occupies the area. The land area that was previously flooded by the dam is now mainly wet meadow.

The impacts of human development can be seen on the map included as Attachment C. Even at the small scale of the map, a number of linear wetland areas can be seen that are in most cases the result of altered surface-water and ground-water flow patterns where roads and railroads have been built. Agricultural development shows up as a number of linear riparian/wetland mixed features associated with irrigation ditches. In the northwestern corner of the project area, south of Manhattan, return flow from irrigation on the Madison Plateau has created a number of artificial wetland and riparian features.

Table 7 summarizes the results of the inventory of wetlands and riparian areas, which represent an assessment of how much area these features presently cover within the project area. The total areas mapped in each category and the number and size range of mapped features are shown, along with the statistics for the NWI mapping for comparison.

Table 7
Summary of Inventoried Wetlands and Riparian/Wetlands Mixed Areas

2001-2003	Total Area	% Of Area	Largest Unit	Smallest Unit	Unit Count
Wetlands	8,981 Acres	2.7 %	706 Acres	0.31 Acres	405
Riparian/Wetlands	13,924 Acres	4.2 %	960 Acres	0.16 Acres	530
Combined Totals	22,905 Acres	6.9 %	N/A	N/A	931
NWI Results	4,755 Acres	1.4 %	209 Acres	0.01 Acres	2,449

The main wetland types present with the *wetlands* layer are summarized in Table 8. Marsh areas often contained a variety of willows along with cattails and emergent vegetation. Wet meadows proved to be the most diverse wetland type in the Gallatin Valley. The wet meadow classification includes those areas immediately adjacent to river and ponds, sites down-slope of leaking irrigation or drainage ditches, low-lying areas of irrigated pastures, and areas immediately up-slope of road beds. Wet meadow areas were most commonly composed of grasses, sedges and some forbs, with minimal populations of shrubs or trees. Wet meadow wetlands covered a total area of 3,170 acres and represent 35% of the total area inventoried within the *wetlands* layer.

The dominant types of wetlands inventoried within the *wetlands* layer were riparian and wet meadow wetlands. Many of the wetland areas contained mixed wetland types. Note that the areas shown in Table 8 do not include the wetlands within the *riparian/wetlands mixed* layer. Over 50% of the areas mapped as *wetlands* were classified as riparian wetlands, covering an area of 4,740 acres. This statistic suggests that additional land area within the project contains riparian wetlands that could not be seen on the CIR imagery and are included in the *riparian/wetlands mixed* layer. If the wetlands included within the *riparian/wetlands mixed* layer were included the total area of wetlands in the Gallatin Valley would be significantly greater than the 8,981 acres inventoried in the *wetlands* layer.

Table 8
Summary of Dominant Wetland Types in the Wetlands GIS Layer

Wetland Type	Unit Count	Total Area (Acres)	% Total Wetland Area (8981 Acres)
Marsh	20	204	2.3
Riparian	186	5,611	62.4
Wet Meadow	199	3,174	35.3
Total Wetlands	405	8,989	100

GIS Project CD

To make the information compiled for the project available to the public a GIS data CD was created. The final GIS database constructed for the project contains the layers constructed for “*wetlands*” and “*riparian/wetlands mixed*”. The project also contains a significant amount of related data. The GIS data CD is available from the Gallatin Local Water Quality District, with the following information:

- 1) A 5-meter resolution CIR image of the entire project area
- 2) The *Wetlands* GIS layer (shapefile)
- 3) The *Riparian/Wetlands Mixed* shapefile
- 4) A shapefile showing the maximum historical extent of wetlands and riparian areas
- 5) A shapefile for the NWI wetlands inventory
- 6) A shapefile for the project area boundary
- 7) A shapefile for the ground-truth sites
- 8) A shapefile showing areas of hydric soils
- 9) A JPEG file of a map showing the historical and current conditions

Attributes of the *Wetlands* GIS Layer

As previously mentioned, the intent of this project was to identify areas exhibiting the hydrologic and vegetative characteristics of wetlands. ***The areas inventoried as wetlands do not represent delineated jurisdictional wetlands.*** Conservatively speaking, all of the areas inventoried are considered ecological wetlands, although the soil and hydrologic conditions may not always satisfy legal requirements of a wetland. The following descriptions are provided for the attributes contained in the data table associated with the wetlands layer in the GIS project:

Area (m²) = Total areal coverage of a particular wetland polygon.

Perimeter (m) = Total linear distance of the lines defining the wetland.

Acres = Total areal coverage of a particular wetland polygon in acres.

Hydrology = A statement of the basic hydrologic conditions in a mapped polygon.

Surface (*Surf*) means that standing or running water is visible on the site. *Soil* indicates that the moisture on the site is primarily contained as soil moisture.

Draining = This attribute may be used in reclamation efforts by identifying wetlands that have previously been or are currently being drained.

Y = Yes, draining is visible on this site.

P = Possible draining on this site, or on adjacent parcels.

N = No, visible signs of draining associated with this site.

Tree Species = A listing of the dominant tree species present, listed in order of decreasing dominance. Dominance was determined by the species occupying the largest percentage of the mapped area.

Shrub Species = A listing of the dominant shrub species present, listed in order of decreasing dominance. Dominance was determined by the species occupying the largest percentage of the mapped area.

Wetland Type = These descriptions are categorizations of visible wetland characteristics. Many wetland polygons are complexes involving one or more of the following wetland types.

Wet Meadow = Areas dominated by grass and/or forbs that occur in low-lying areas of grasslands or agricultural fields.

Riparian = Areas dominated by tree and shrub vegetation that occur on the periphery of rivers, streams, and irrigation or drainage ditches. Surface water or extremely high soil moisture can be seen through the vegetation canopy at these sites.

Marsh = These areas are dominated by standing water and often contain emergent hydrophilic vegetation.

Influences = This attribute field is used to list any extraneous factors associated with this particular wetland feature.

Constructed (artificial) ponds = Wet meadows and marshes often form immediately upstream or downstream of excavated pond sites.

Roadbed = The presence of railroad, highway, or unpaved roads changes hydrologic flow patterns. As a result marsh, riparian, and wet meadow wetlands form as surface and subsurface flow is blocked by roadbed features.

Irrigation drainage = Local topographic variation occasionally leads to the concentration of runoff from agricultural irrigation systems. This concentrated runoff collects in small depressions, resulting in the formation of wet meadows or marshes.

Irrigation canal = Sharp bends, debris or other constrictions of irrigation canals may lead to water leakage over the top or through the sides of the canal walls.

Combinations of fine grained soils and depressional topography in the areas down-gradient of the leak can lead to the formation of wet meadow or riparian wetlands.

Residential (Res) Development = The presence of residential buildings and landscaping often creates distinct breaks in natural hydrologic conditions. The effects of human activities near wetland areas could alter the size or ecological health of associated wetlands.

Attributes of Riparian/Wetland Mixed GIS Layer

The GIS layer showing the current condition for the *riparian/wetlands mixed* layer is shown on the map included as Attachment A. The *riparian/wetland mixed* GIS layer includes areas immediately adjacent to streams and rivers that are typically dominated by cottonwood, willow, alder, and occasionally aspen trees. Willows may be classified as either trees or shrubs. In the attribute table for this layer they were placed in the tree-vegetation class. Additionally, the riparian/wetland mixed layer also includes some of the drier sites that support juniper trees along with hawthorne, chokecherry, and snowberry shrubs. The following descriptions are provided for the attributes contained in the data table associated with the riparian/wetlands mixed layer in the GIS project:

Area (m²) = Total areal coverage of a particular wetland polygon.

Perimeter (m) = Total linear distance of the lines defining the wetland.

Acres = Total areal coverage of a particular wetland polygon in acres.

Tree Species = Lists the dominant trees present in order of decreasing dominance.

% Woody Vegetation = Estimated percentage of the area covered by woody vegetation.

Shrub Species = A listing of the dominant shrub species present, listed in order of decreasing dominance. Dominance was determined by the species occupying the largest percentage of the mapped area.

Notes = Observations of human or natural conditions with the feature.

Constructed (artificial) ponds = Wet meadows and marshes often form immediately upstream or downstream of excavated pond sites.

Roadbed = The presence of railroad, highway, or unpaved roads changes hydrologic flow patterns. As a result marsh, riparian, and wet meadow wetlands form as surface and subsurface flow is blocked by roadbed features.

Irrigation drainage = Local topographic variation occasionally leads to the concentration of runoff from agricultural irrigation systems. This concentrated runoff collects in small depressions, resulting in the formation of wet meadow or marsh wetlands.

Irrigation canal = Sharp bends, debris or other constrictions of irrigation canals may lead to water leakage over the top or through the sides of the canal walls. Combinations of fine grained soils and depressional topography in the areas down-gradient of the leak can lead to the formation of wet meadow or riparian type wetlands.

Residential (Res) Development = The presence of residential buildings and landscaping often creates distinct breaks in natural hydrologic conditions. The effects of human activities near wetland areas could alter the size or ecological health of associated wetlands.

W. Gallatin/E. Gallatin:

Flood scar = Sites along the banks of a river where recent floods have removed the majority of established vegetation.

Corridor = Vegetated sites that are immediately adjacent to the river system named.

Island = An isolated site that was formed by the braiding and subsequent rejoining of a primary river channel.

Gallatin Corridor = is a geographic location entry used to indicate the riparian sites located downstream of the confluence between the East Gallatin and West Gallatin rivers.